

VIII. POST-HARVEST TECHNOLOGY OF MAJOR CROPS IN NEPAL

Khadga B. Shrestha¹

A. Introduction

Nepal is a landlocked kingdom bordered by China in the north and India in the east, west and south as its good neighbors. It extends between latitude of 26°22' to 30°27'N, longitude of 80°04' to 88°12'E and altitude range of 70 to 8,848m above mean sea level, the lowest and the highest spot being the height of Kechanakal in the southern plain and the peak of the Mount Everest.

Administratively, it is divided into 5 development regions, 14 zones, and 75 districts. The urban area consists of 1 metropolitan city, 3 sub-metropolitan cities and 54 municipalities; whereas, the rural sector is constituted of some 3,913 village development committees (VDCs). The VDC is the smallest unit of the local government.

Nepal is divided into five ecological zones including Terai plain, Siwalik, middle mountain, high mountain and the high Himalaya. However, it is considered as Terai, hills and mountain. In the plains, the climate is warm-tropical; whereas, the hilly area has sub-tropical to sub-alpine climate. The country is extended to an area 147,181 sq. km. The total land area is 14,718,000 ha, which is constituted of 14% (Terai plain), 14% (Siwalik), and 19% middle mountains, 30% high mountains and 23% (high Himalayas). About 20% of the total land area is always covered with snow. The total cultivated land is 2.97 million hectares, while the total cultivable land is 2.32 million hectare. Some 28.5 % of the cultivated land area is irrigated. The Terai plain, Siwali, middle mountain, high mountain and high Himalayas have the altitude range of 100-300m, 150-800m, 300-1500m, 1500-5000m and more than 2600m (amsl). The land use pattern is found to be 20% cultivated land, 7% non-cultivated land, 29% forest, 11% shrub land, 12% grassland and 21% others. The soil type is found to be silty loam to silt in the Terai plain, sandy loam to silty loam in the inner Terai, shallow and coarse texture in the Siwalik range, sandy loam to silty loam in the river valleys, loam to silty clay in the hilly land and shallow stony and rocky in the mountain land.

B. Socio-economic status

According to the census report (2001), the total population in the country is about 23 million, of which 88% dwell in the rural environment; whereas, about 81% live on farming. On the basis of operational land holding, farm sizes are grouped into four categories as large, medium, small and marginal. About 64 percent of the total

¹ Scientist (S2), Agricultural Engineering Division, Nepal Agricultural Research Council, Khumaltar, Lalitpur, Nepal.

farm families of Nepal operate are small and marginal size of land. The man-land ratio in these farm groups is the lowest in the world.

About 54% of the total population is literate. Some 42% of the total population is economically deprived and living below the poverty line. The economically active population is 9.9 million, of which 4.29 million are female. The gross domestic product (GDP) is US\$² 5,080 million during the fiscal year 2000/2001, of which agricultural sector contributes US\$ 2,037 million. The gross national product (GNP) per capita of Nepal stands at US\$ 234.

C. Agricultural status

The total land area available for cultivation is 2.97 million hectares out of which, the cultivated land area is 0.99 million hectares. Rice and wheat are the major cereal crops in the Terai region, while maize is the main crop in the hills and the mountain areas. After maize finger millet is grown extensively in the hills and mountain in the marginal lands having low productivity. In addition to these cereals and millet, barley is also grown. In addition to these cereal crops, legumes are also grown in a considerable area. Sugarcane, jute and tobacco are the major industrial crops. Besides these, oilseeds, potato, vegetables and fruits are also grown as cash crops. Cabbages, cauliflower, beans, okra and tomato are major vegetables, while citrus (mandarin, sweet orange and lime), mango, banana and apple are the main fruits. The agricultural production status (area, production and productivity) of some of the major crops is presented in Appendix (Table 8.1).

D. Food situation

Rice is the main staple food in Nepal. Those who cannot afford rice live on maize and millet especially in the inaccessible hilly and mountainous region. The total edible cereal production in the country was 7.2 million tonnes (2000/2001) while total edible cereal required for the country is 4.4 million tones, which show a net surplus of 2.8 million tones of edible cereals in balance in Nepal. Because of the characteristics of the natural terrain of the country, the edible cereal production is mostly concentrated in the Terai plain. Though the Terai area produce surplus food, edible cereal production in the hills and mountains is not sufficient to meet the food demand of the people for a complete year. Majority of youths from the hills and mountains, therefore, seasonally migrates to India in search of jobs.

Because of the marginal production, inhabitants dwelling in the hills and the mountains occasionally face food crisis. His Majesty's Government of Nepal usually airlifts the cereal food grains to these food deficit districts in the hills and the mountains to feed the hungry mouths at a subsidized rate. Realizing regular food deficit in the hills and mountains, the Government of Nepal has prioritized Terai area

² US\$ = NRs. 74.10 (30th October 2003)

for cereal production, hills for horticultural crops and mountains for livestock development in its Agricultural Perspective Plan (APP) for 20 years.

E. Post-harvest technology

1. Rice

The meal is said to be incomplete without rice. Hence, the Nepalese farmers are very cautious about this crop. The Terai plain in the southern part of the country near India border is the main region producing rice. This belt is said to be the granary of the country. Farmers harvest two rice crops from the area having favorable climate. The early rice is harvested during the rainy season and hence, farmers generally face drying as well as storage problems. The rice grains are generally stored in the Terai in outdoor structures, locally called Beri (bamboo structure). The rich farmers keep the wooden structure known as Kath-ko-bhakari. In the hills and the mountains, some of the affluent farmers only can afford for eating rice while majority of the small farmers can hardly eat rice for a period of three months. The small farmers from the hilly and the mountainous regions hardly face the storage problems. The rich and the medium-level farmers have storage problems to some extent. Realizing this, His Majesty's Government of Nepal, in joint collaboration with the Food and Agriculture Organization (FAO), launched a Rural Save-Grains Project. Under this project, metal bins were distributed to the needy farmers.

2. Maize

The maize is the second major crop after rice. About 67% of the total land area is covered by the improved maize varieties. With the increased production due to the adoption of improved maize varieties, however, the post-harvest losses also increased. The main cause of post-harvest losses is owing to the traditional methods of storage. Because of the tenderness of maize kernels of the improved varieties, they are more prone to rodent and insect damages than the local maize varieties. Sun drying is the only technology available to the farmers. The maize in ears are stored in a local structure known as Thangro, which is an outdoor structure, while the maize grains are stored in a variety of indoor structures, including Bhakari (woven bamboo structure), Dehari (mud bin), Ghyampo (earthen structure) etc. Under the financial assistance of the Hill Maize Research Project (HARP), the Agricultural Research Station (ARS) at Khajura, Nepalgunj has made some improvements on Thangro and Bhakari with the objective of reducing storage losses. The result is encouraging.

3. Wheat

The wheat is the third major crop grown in Nepal. Most of the land areas remain fallow during the winter season because of the lack of irrigation facilities. Power operated wheat threshers are available to the rich farmers in the Terai area. The majority of farmers thresh wheat manually. The Agricultural Engineering Division of

Nepal has modified the pedal operated paddy thresher for wheat threshing.

4. Potato

Although this crop is cultivated in all zones of the country main concentration of resources in terms of research and development is focused on the upper parts of mid-hills and mountains both as a staple food for local consumption and seed source for lower parts of the country. National Potato Research Program has been initiating and coordinating the potato research program in the country. Appropriate refrigerative storage is a major post-harvest problem for potatoes.

5. Citrus fruits

Of the horticultural crops, citrus fruits occupy a major share in the country. The major citrus fruits are mandarin, sweet orange and lime. The citrus fruits in Nepal are good in quality, taste, color and freshness. However, these fruits could not fetch a good international market because of rotting that occurs due to wrong methods of fruits harvesting. The fruits are harvested by shaking the tree branches. The fruits are often damaged while falling on the ground. Such impacts cause scratches and damage which ultimately causes rotting due to the fungus attack. Fruit picking is a major problem in Nepal as the citrus trees in Nepal are of tall variety. Planting dwarf varieties of citrus fruits takes some 30 years for better harvest. It is not an easy operation. Hence citrus fruit harvester is a present day need in Nepal. Besides harvesting storage, grading, packing and transporting are the other major problems in the post-harvest stage.

6. Ginger

The upland in the mid-hills (450 to 1,400m altitude above mean sea level) is most suitable for fresh ginger production. The internal as well as the external markets for this crop is excellent. It is, therefore, a better cash crop for the rural farming community living in the mid-hills of the country. In spite of being a source of income generation, the area under this crop and number of participating farmers remain stagnant due to several problems. Lack of ginger peeler and the mechanical dryer are the major post-harvest problem. Ginger Research Program (GRP) under Nepal Agricultural Research Council (NARC) at Kapurkot, Salyan is mainly responsible for addressing the problems on ginger. Hence, the GRP in association with Agricultural Engineering Division (AED) under NARC has attempted to develop a ginger peeler and a ginger dryer under Hill Agriculture Research Project (HARP). However, the result was not encouraging. Though ginger is a potential income-generating crop, farmers have not been able to cash it to the possible extent. There is, therefore, a need to develop post-harvest equipments such as ginger peeler, ginger dryer, etc.

7. Cardamom

In the mid-hills of the Eastern Development Region (EDR), the upper land area (1,200-1,900m amsl) is being utilized for production of greater Cardamom (*Amomum Subulatum* Roxb.). Cardamom is at present either sun-dried or dried in locally made traditional dryer using firewood. Use of firewood is neither economical nor hygienic. The conventional method of smoke drying is at present the main cause of unpleasant smell as well as odd color and appearance, due to which the farmers cannot fetch good price. Lack of better type of Cardamom dryer is, therefore, another engineering problem associated with this crop. These problem need to be resolved for attracting the farming community again towards this crop for better income.

F. Major issues

General:

- Marketing channel for the major crops produced in remote hills of Nepal.
- Lack of production of value-added products and their marketing in the remote, inaccessible hills.
- Use of traditional millings facilities such as stone mortar and wooden pestle, treadle husker, rotary quern, watermill for cereal crops.

Rice:

- Unavailability of power-operated paddy threshers.
- Paddy dryer for early paddy.
- Improved storage structures.

Maize:

- Lack of dryers for cobs and kernels.
- Improved storage structures.

Wheat:

- Lack of both manual and power-operated wheat threshers.
- Lack of mechanical wheat dryer.
- Improved storage structures.

Potato:

- Lack of suitable storage technology at the village level.

Citrus Fruits:

- Fruit storing, grading, packing and transporting.

Ginger:

- Lack of improved ginger peeling and ginger drying.

Cardamom:

- Cardamom drying in traditional dryer.

G. Summary and conclusions

Modern mills are available in the Terai area; whereas, people have to rely on mortars and pestle, treadle husker, rotary quern and watermill in the remote hilly districts, and hence improved milling facilities are required in the remote inaccessible rural areas of the hills and mountains. In addition, mechanical dryers, improved storage structures are required for major cereals including rice, maize and wheat; the threshing equipments are also required for these crops. Storage structures are required for potato as well as citrus fruits. Improved post-harvest technology on grading, packing and transporting of citrus is also required. Improved drying technologies are also required for ginger as well as cardamom; in addition to the mechanical dryer, the peeling equipment is also required for ginger.

References

Adhikary, S. K. (2000). Nepal Country Paper. Paper presented at Technical Advisory Committee (TAC) and Governing Body (GB) Meeting of Regional Network for Agricultural Engineering and Machinery (RNAEM) at Rongcheng, China. October 19-21, 2000.

Anonymous (1999/2000). Annual Agriculture Development Program and Achievement. Annual Reports (In Nepali). District Agriculture Development Office, Sindhulimadhi, Sindhuli.

Anonymous (1999/2000). Annual Progress Report. Horticulture Center. Sindhuli.

Anonymous (1999/2000). Annual Agriculture Development Program and Achievement. Annual Reports (In Nepali). District Agriculture Development Office, Dhankuta.

Anonymous (2000/2001). Annual Report. Agricultural Implement Research Center, Nepal Agricultural Research Council, Ranighat, Birgunj, Parsa District, Narayani Zone, Nepal.

APP (1995). Agriculture Perspective Plan (FY 2052/53 – 2071/72): Summary. National Planning Commission, His Majesty's Government. November 1995.

APROSC (1982). A Study on Farm Level Grain Storage Practices in Nepal. Agricultural Projects Services Centre, Ramshah Path, Kathmandu, Nepal. March 1982, p. 120.

ASD (1998/99). Statistical Information on Nepalese Agriculture. Agriculture Statistics Division, Ministry of Agriculture, Singh Durbar, Kathmandu, Nepal.

Budathoki, Kedar and Bhola Man Basnet (1998). Development of Horticulture in Nepal. Paper presented at Seventeen Meeting of the SAARC Technical Committee on Agriculture, New Delhi, and 15-17 February 1998.

Budhathoki, Kedar (2003). Conservation and Use of Native Tropical Fruit Species Biodiversity in Asia. (IPGRI-ADB-TFT Project): Conservation and Use of Mango and Citrus Species Biodiversity in Nepal (Country Project, January 2000-September 2003). Nepal Agricultural Research Council (NARC), Singh Durbar Plaza, Kathmandu, Nepal, p. 25.

CBS (2001). Statistical Year Book of Nepal 2001. Central Bureau of Statistics,

National Planning Commission Secretariat, His Majesty's Government, Ramshah Path, Thapathali, Kathmandu, p. 447.

CBS (2002). Population Census 2001: National Report. Central Bureau of Statistics, National Planning Commission Secretariat, His Majesty's Government in Collaboration with UNFPA, Nepal. June 2002, p. 263.

CDS (2001). Annual Report of Citrus Crops. Citrus Development Section, Department of Agriculture Development. His Majesty's Government of Nepal. Kirtipur, Kathmandu, Nepal.

Karki, A. B. and D. Chapagain (1989). Review of the Existing National Policies and Strategies for Agricultural Mechanization in Nepal. Regional Network for Agricultural Machinery (RNAM). Los Banos, the Philippines.

Karki, A. B. (1999). Status of Agricultural Mechanization Industry in Nepal. National Workshop on Agricultural Mechanization in Nepal (Agrimech'99). Nepalese Society of Agricultural Engineers (NSAE), Kathmandu, Nepal. 10-11 June 1999.

Manandhar, G. B., S. K. Adhikary, I. P. Upadhyay, R. Rasaily, K. B. Shrestha and D. Gauchan (2000/2001). Study on Existing Citrus Storage Method in Nepal. Annual Report. Agricultural Engineering Division (National Institute of Regional Network for Agricultural Machinery/Nepal), Nepal Agricultural Research Institute, Nepal Agricultural Research Council, Khumaltar, Lalitpur.

Manandhar, G. B. (2002). Nepal Country Paper. Paper presented at the 23rd Technical Advisory Committee (TAC) and 22nd Governing Body (GB) Meeting of Asia Pacific Centre for Agricultural Engineering and Machinery (APCAEM) in Beijing, China. November 25-27, 2002.

Manandhar, D. N., J. K. Ransom and N. P. Rajbhandari (2000). Developing and Disseminating Technology to Reduce Post-harvest Losses of Maize. Proceedings of a Working Group Meeting of the Hill Maize Research Project, Khumaltar, Lalitpur,

Nepal Agricultural Research Council (NARC), 25-27 September 2000. International Maize and Wheat Improvement Center (CIMMYT) and Hill Maize Research Project (HMRP), p. 63.

Paudel, Khadga Bhakta (2003). Role of Storage Technologies in Citrus Fruit Enterprises (In Nepali). Paper presented at Stakeholders Meeting on Storage Technology of Mandarin and Sweet Orange held on Chaitra 7, 2059 at Horticulture Center, Kirtipur. Agricultural Research Station, Lumle. March 21, 2003.

Paudel, Khadga Bhakta, Ishwari Prasad Gautam, Jit Lal Shrestha, Kalika Prasad Upadhyay, Jit Narayan Chaudhary and Bhogendra Kumar Khatri (2003). Simple

Technology for Storage of Mandarin in Improved Cellar Store and Its Construction (In Nepali). Agricultural Research Station, Lumle, Pokhara, Kaski, Nepal, p. 24.

Paudyal, Krishna Prasad and Yogesh Hari Shrestha (2002). Recommended Citrus Fruit Varieties in Nepal (In Nepali). National Citrus Fruits Research Program, Paripatle, Dhankuta, p. 18.

Paudyal, Krishna Prasad (1998). Evaluation of Genetic Diversity of Pummelo in Nepal and Improvement of Propagation Technique. Ph. D. Thesis submitted to Faculty of Engineering and Applied Science, Department of Civil and Environmental Engineering, University of Southampton.

PHLRS (2003). Post-harvest Technologies Recommended for Handling Mandarin. Post-Harvest Loss Reduction Section, Shreemahal, Pulchowk, Lalitpur, Nepal.

RARS (2003). Improved Thangro and Bhakari for Maize Storage (In Nepali). Regional Agricultural Research Station, Nepal Agricultural Research Council, Nepalgunj, Khajura, Banke. July 2003, p. 18.

RSGP (1992). Proceedings of the National Seminar on “Issues and Constraints related to Post-harvest Food Losses Management” held at Kathmandu from 27 to 29 April 1992. Rural Save Grain Project (HMG/FAO), p. 161.

Shrestha, Krishna Bahadur (1996). Appropriate Post-harvest Technology of Fruits in Nepal. Udaya Research and Development Services (P) Ltd., Kathmandu, Nepal, p.110.

Appendix

Table 8.1 Agricultural status in Nepal

(Area: 000 hectares; Production: 000 tons)

Agricultural Crops		Area (Ha)	Production (tons)	Productivity (tons/ha)
1.0	Food Grain Crops (2000/2001)	3,313,681	7,171,782	
1.1	Rice	1,560,044	4,216,465	2.70
1.2	Maize	824,525	1,484,112	1.80
1.3	Wheat	641,030	1,157,865	1.81
1.4	Hill crops			
	1.4.1 Finger millet	259,888	282,852	1.09
	1.4.2 Barley	28,194	30,488	1.08
2.0	Grain Legumes (2000/2001)	306,220	243,243	0.79
3.0	Cash Crops (2000/2001)			
3.1	Oilseeds	188,455	132,331	0.70
3.2	Industrial Crops			
	3.2.1 Sugarcane	59,422	2,211,781	37.22
	3.2.2 Jute	14,535	15,175	1.04
	3.2.3 Tobacco	4,226	3,973	0.94
3.3	Horticultural Crops			
	3.3.1 Potato	129,019	1,313,717	10.18
	3.3.2 Citrus fruit			
	■ Sweet orange	10,508	66,654	10.6
	■ Mandarin orange	3,758	23,817	11.3
	■ Lime	2,778		7.5
	3.3.3 Vegetable	149,030	1,489,665	9.99

Table 8. 2 Pre-storage loss of food grains

Ecological Region	Pre-storage Loss, %				
	Harvesting	Transporting	Threshing	Drying	Total
Tara					
Paddy	1.50	1.20	1.45	1.73	5.88
Wheat	2.33	1.99	2.90	1.21	9.12
Maize	0.30	-	0.27	1.05	1.83
Total					16.83
Hills					
Paddy	1.73	1.14	1.14	1.72	5.73
Wheat	0.68	0.58	0.73	0.71	2.72
Maize	0.62	0.25	0.76	0.48	2.09
Total					15.54
Mountain					
Paddy	1.61	1.15	1.12	1.13	5.01
Wheat	1.55	9.62	1.93	1.44	5.54
Maize	0.39	0.15	0.59	1.03	2.07
Total					12.62

Table 8. 3 Percentage loss of food grains in all structures

Crops	Ecological Belt			Nepal
	Terai	Hill	Mountain	
Paddy				
Rodent	4.1	3.0	2.5	3.7
Insect	2.6	2.5	1.6	2.5
Mould	-	0.05	0.04	0.04
Total	6.7	5.55	4.14	6.22
Maize				
Rodent	12.4	3.5	5.6	4.6
Insect	0.7	3.9	2.2	3.1
Mould	-	-	0.2	0.2
Total	13.1	7.4	8.0	7.6
Wheat			5.4	
Rodent	4.4	2.6	6.2	4.1
Insect	7.6	4.6	3.3	6.0
Mould	-	0.2	0.1	0.1
Total	12.0	7.4	9.6	10.2
Millet				
Rodent	-	5.0	5.4	5.1
Insect	-	-	-	-
Mould	-	0.2	0.3	0.3
Total	-	5.2	5.7	5.4

Table 8.4 Percentage loss in various structures

Structure	Average Percentage Loss for All Grains		
	Tarai	Hills	Mountain
Dehari	-	2.6	6.9
Chitra-ko-bhakari	5.6	7.0	10.4
Thangro	9.1	7.4	7.9
Beri	-	8.4	3.8
Kath-ko-bhakari	-	3.0	6.0
Dhikuti	4.4	5.5	-
Gagro	4.1	7.1	-
Thunse	6.0	4.7	-

Country profile of Nepal

General

Location

- Latitude 26⁰ 22' to 30⁰ 27' N
- Longitude 80⁰ 04' to 88⁰ 12' E
- Altitude 70 to 8,848 m (amsl)

Climate

Warm-tropical to sub-alpine

Annual rainfall

2,000 mm (East) to 1,000 mm (West)

- Highest rainfall 4,070 mm (Pokhara)
- Rainfall duration 60-80% (Monsoon season)

Population

22.74 millions

- Total rural population 88%
- Farming population 80.6%
- Literacy rate 53.7%
- Population below poverty line 42%
- Economically active (total) 9.9 million
- Economically active (female) 4.29 million
-

Economic situation

- Gross Domestic Product US\$ 5,080 million
 - Agriculture sector 40.1%
 - Non-agriculture sector 59.9%
- Gross National Product/Capita US\$ 234

Total Land Area

147,181 sq km

- Terai plain 14%
- Siwalik 14%

- Middle Mountain 19%
- High Mountain 30%
- High Himalaya 23%

Land holding size

- Terai 1.26 ha
- Hills 0.77 ha
- Mountain 0.68 ha
- Average size 0.96 ha

Land use pattern

- Cultivated land 20% (2.97 million ha)
- Non-cultivated land 7%
- Forest 29%
- Grassland 12%
- Shrub 11%
- Others 21%

Cultivable Area 0.99 million hectares

Irrigated Area 28.5% of the total cultivated area

Cropping intensity 1.75

Soil type:	Land type:	Soil type:
1.	Terai	Silty loam to silt
2.	Inner terai	Sandy loam to silty loam
3.	Siwalik	Shallow and coarse texture
4.	River valleys	Sandy loam to silty loam
5.	Hilly land	Loam to silty clay
6.	Mountain land	Shallow stony and rocky

Major Cereals:

Soil Type	Crops	Area, ha	Production, ton	Productivity, ton/ha
1.	Rice	1,560,044	4,216,465	2.70
2.	Maize	824,525	1,484,112	1.80
3.	Wheat	641,030	1,157,865	1.81
4.	Finger millet	259,888	282,852	1.09
5.	Barley	28,194	30,488	1.08
	Total	3,313,681	7,171,782	

Cash Crops:

Soil type	Crops	Area, ha	Production, ton	Productivity, ton/ha
1.	Sugarcane	59,422	2,211,781	37.22
2.	Potato	129,019	1,313,717	10.18
3.	Tobacco	4,226	3,973	0.94
4.	Oilseeds	188,455	132,331	0.70

Agricultural machine power:

1.	Total tractors	23,991 Nos.
2.	Two-wheel tractors	1,300 Nos.

Availability of farm power: 0.99 hp/ha
(Horse power availability per unit of cultivated land)

Availability of power:

1.	Human labor	37%
2.	Animal power	40%
3.	Mechanical power	23%